N91-28080

SOLUTION GROWTH OF TRIGLYCINE SULFATE (TGS) CRYSTALS ON THE INTERNATIONAL MICROGRAVITY LABORATORY (IML-1)*

R.B. Lal, A.K. Batra, and Li Yang**
Department of Physics
Alabama A&M University
Huntsville, Alabama

and

W.R. Wilcox
Clarkston University
Potsdam, New York

and

J.D. Trolinger
MetroLaser
Irvine, California

ABSTRACT

An experiment has been planned for the International Microgravity Laboratory (IML-1) to be launched around February, 1991. Crystals of triglycine sulfate (TGS) will be grown by low temperature solution crystal growth technique using a multiuser facility called Fluid Experiment System (FES). A special cooled sting technique of solution crystal growth will be used where heat is extracted form the seed crystal through a semi-insulating sting, thereby creating the desired supersaturation near the growing crystal. Also, a holocamera will be used to provide tomography of the three dimensional flow field and particle image dispacement velocimetry to monitor the convective flows.

* Work supported by NASA contract NAS8-36634.

** Graduate Student

SOLUTION GROWTH OF TRIGLYCINE SULFATE (TGS) CRYSTALS ON THE INTERNATIONAL MICROGRAVITY LABORATORY (IML-1)

Introduction

In the Spacelab-3 flight flown in 1985, the Fluid Experiment System (FES) was used to conduct crystal growth experiments to help in the understanding of the solution growth of crystals in a micro-gravity environment. This paper describes the reflight of the FES on the IML-1 mission to be flown on Spacelab mission in early 1991, with different objectives and a refined optical system. The objectives of the experiment are 1) to grow crystals of TGS using a modified version of the Fluid Experiment System (FES), 2) to study the holographic interferometry tomography of the fluid in three dimensions, and 3) to study the fluid motion due to g-jitter by measuring the fluid velocity using simple multiple exposure holography of tracer particles and to study the influence of g-jitter on the growth rate of TGS crystals.

Importance of TGS

Triglycine Sulfate (TGS) is a good model material for solution crystal growth. TGS crystals can be grown at considerably low temperatures like 30-45° C, TGS solution is transparent and so holographic techniques can be used to study the fluid properties, considerable ground based work has been completed, and it is easy to handle. Apart from this, TGS has technological importance for pyroelectric infrared detectors which require no cooling as compared to quantum detectors. The present devices have detectivities (D*) from 5×10^8 - 1×10^9 $cm\ Hz^{1/2}$ / watt. This is about an order of magnitude away from the theoretical value for a pyroelectric bolometer operating at room temperature. This difference is expected to be due to the dielectric loss in the material.

Growth of Crystals Using FES and Cooled Sting Technique

During the IML-1 mission TGS crystals will be grown from an aqueous solution using a specially developed technique of cooled sting[2]. Many crystals of TGS have been grown in the laboratory using the cooled sting technique and the growth rate is monitored using a three axes movement telemicroscope. During the IML-1 mission, two experimental runs are planned where the saturation temperature of the TGS solution will be around 45°C. In the first experiment a polyhedral seed with (010) orientation will be used; in the second experiment a similar seed with (001) orientation will be used.

In the absence of convection, crystal growth from solution will rapidly become slower as the adjacent solution layer is depleted in solute, unless the growth in temperature is lowered to compensate. However, if the temperature is lowered too fast, the growth rate will reach a level where sovent inclusions are formed. To accomplish a uniform growth rate, the temperature is lowered at a programmed rate. This can be done by programming down the walls of the growth cell. However, in reduced convection or in the absence of convection, only change of temperature of the walls would require a long time to inwards towards the crystal. On the other hand, controlling the temperature of the sting in intimate contact with the crystal should allow the growth rate to be held constant. Details of this have been given earlier[3]. Details of the flight growth cell are given in fig. 1.

Planned Crystal Growth Runs on IML-1 Mission

The first crystal growth run will be for a period of about 1 day. During this run, the fluid flow in three dimensions will be studied. To achieve this, TGS solution will be seeded with small particles that can be imaged by holography to show the direction and velocity of fluid movements. The present plans include the use of polystyrene microballons added to the fluid as tracer particles. In this run a seed crystal of TGS with (010) orientation will be used. The data from the first run will be used to grow a high quality single crystal during the second run that will last several days. No tracer particles will be used during this run, because they would contaminate the crystal by forming inclusions and other defects. A three dimensional view of the crystal and flow field can be recorded by applying holographic optical elements to the crystal growth cell. Tomography is made possible by passing light through the FES windows at three different angles. Studies have shown that this will be sufficient to extract three dimensional density data from the field of the type anticipated. Details of the optical holography system are published elsewhere[4].

On the IML-1 mission, the accelerations that cause convection and disturb crystal growth will be carefully monitored. In addition to an internal FES accelerometer that measures accelerations above 5 Hz, the Space Acceleration Monitoring System (SAMS) has two accelerometers located near the FES crystal growth cell and one more mounted in the Spacelab aisles. This special set of accelerometers measures low-frequency (0 to 5 Hz) vibrations that are harmful to crystal growth experiments.

Analysis of the Crystals

Considerable ground-based data have been generated for TGS crystals grown by a similar technique. After the mission the grown crystal will be returned to our laboratory for extensive analysis of their structure and electrical and other physical properties, including their infrared detection characteristics. The space-grown crystals will be compared with crystals grown by commercial companies. The detector characteristics of the ground crystals and later for the flight crystals will be measured at EDO/Barnes Engineering Division, Shelton, Connecticut.

Acknowledgments

The authors would like to thank The National Aeronautics and Space Administration, Office of Microgravity Science and Applications for the support of this work through a contract. Thanks are also due to Rudy Ruff, William Witherow, David McIntosh, Todd Macleod, and David Johnston of NASA/Marshall Space Flight Center for their continued support during the preparation of this experiment.

References

1. Yoo, Hak-Do, Wilcox, W.R., Lal, R.B., and Trolinger, J.D. J. Crystal Growth, 1988, 92, 101.

2. Lal, R.B., Aggarwal, M.D., Kroes, R.L., and Wilcox, W.R., Phys. Status. Sol(a). 1983, 80, 547.

3. Liu, L.C., Wilcox, W.R., Kroes, R.L., and Lal, R.B., in Material Processing in the Reduced Gravity Environment of Space, Ed G. Rindone (North-Holland, Amsterdam, 1982) p. 389.

4. Trolinger, J.D., Tan, Hung., and Lal, R.B., International Congress on Applications of Lasers and Electro-Optics (ICALEO), San Diego, CA, Nov 9, 1987.

FES TEST CELL

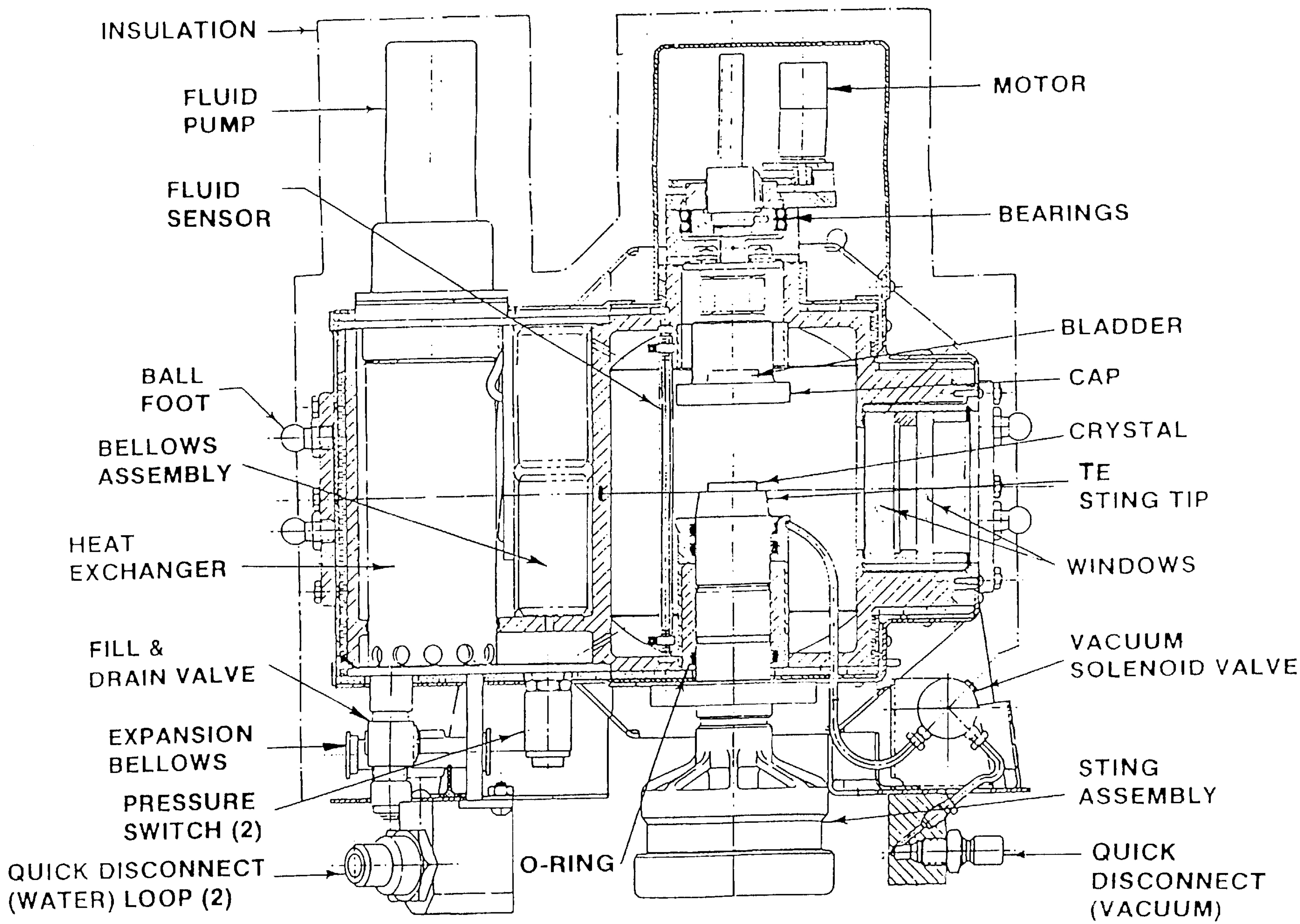

Figure 1.